AEDC-TSR-96-V5

ADVANCED X-RAY ASTROPHYSICS FACILITY INSTRUMENT CABLE CERTIFICATION BAKEOUT TEST

J.D. Sisco, B.L. Seiber, R.A. Dawbarn and T.L. Harris
Sverdrup Technology, Inc., AEDC Group

November 1996

Final Report for Period May 1996 to July 1996

ARNOLD ENGINEERING DEVELOPMENT CENTER
ARNOLD AIR FORCE BASE, TENNESSEE
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE

NOTICES

APPROVAL STATEMENT

This report has been reviewed and approved.

ROBERT W. SMITH
Space & Missile Systems Test Division
Operations Directorate

Approved for publication

FOR THE COMMANDER

EDDIE J. PRESTON, Lt Col, USAF
Chief, Space & Missile Systems Test Division
Operations Directorate

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	November 1996	Final Report for May 1996 - July 1996

4. TITLE AND SUBTITLE

Advanced X-Ray Astrophysics Facility Instrument Cable Certification Bakeout Test

5. FUNDING NUMBERS

PE 921E02
JN 2538 Phase II

6. AUTHOR(S)

J.D. Sisco, B.L. Seiber, R.A. Dawbarn, and T.L. Harris
Sverdrup Technology, Inc., AEDC Group

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Arnold Engineering Development Center/DOS
Air Force Materiel Command
Arnold Air Force Base, TN 37389-4000

8. PERFORMING ORGANIZATION (REPORT NUMBER)

AEDC-TSR-96-V5

9. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)

Max Rosenthal NASA-MSFC
Code TA-61, MSFC
Huntsville, AL 35812

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Available in Defense Technical Information Center (DTIC).

12A. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12B. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The Advanced X-ray Astrophysics Facility - Imaging (AXAF-I) Instrument Cables Pre-bake and NASA/MFSC 1238 SPEC Certification was conducted in the Arnold Engineering Development Center (AEDC) 4 x 10 Thermal Vacuum Chamber and 7V Antechamber, respectively. The flight hardware instrument cables provide the connections to the satellite's sensors and on-board process modules. The instrument cables certified included coaxial, multi-conductor, thermal couple wires, BNC connectors, limit switches, and several other miscellaneous connector devices.

The primary objective of this test project is to de-contaminate/certify cleanliness of the instrument cables developed under the NASA-MSFC AXAF-I program. The NASA/MSFC 1238 Specification certification was performed in two steps. First, all cables were to be pre-baked at 200°F for a minimum of 72 hr and a maximum of 100 hr with a vacuum level of less that 1E-5 torr in AEDC's 4 x 10 Thermal Vacuum Chamber. Upon completion, the cables were placed in AEDC's 7V Antechamber and certified at 160°F with a vacuum level less than 1E-6 torr until TQCM obtained less than 1 Hz/hr rate change for 12 hr and further exposing an Optical Witness Sample (OWS) for 24 hr. The cables were not considered certified until the OWS passed a contaminate reflection test at NASA/MSFC. This report does not include all the data obtained during the tests but describes the particulars of each test phase and presents some typical results from each phase. The equipment used to accomplish the test objectives is also discussed. All the OWS from the test program were transported and certified by NASA/MFSC Contamination Laboratory at the time of each cable certification completion.

14. SUBJECT TERMS

AEDC, Thermal Vacuum, Bakeout, NASA-MSFC 1238 certification, 4 x 10 chamber, heat lamps cable bakeout AXAF-1

15. NUMBER OF PAGES

40

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAME AS REPORT

PREFACE

The work reported herein was performed by the Arnold Engineering Development Center (AEDC), Air Force Materiel Command (AFMC) under Program Element 921E02 at the request of the NASA-Marshall Space Flight Center, Huntsville, AL. NASA/MSFC Program Manager was Max E. Rosenthal of NASA-Marshall Space Flight Center, Huntsville, AL. Robert W. Smith was the AEDC Air Force Project Manager. AEDC Project Engineer was Jimmy D. Sisco of Sverdrup Technology Inc. Test results were obtained by Sverdrup Technology Inc., AEDC gROUP, operating contractor for the Effort T Test Support at AEDC, AFMC, Arnold Air Force Base, TN. The tests were performed in the 4x10 Thermal Vacuum Chamber and the 7V Antechamber from May 1, 1996 through June 20, 1996, under AEDC Project Number 2538 Phase II.

The authors would like to thank Earl Pewitt, Joe McCabe, Rick Bush, Troy Perry, Ronnie Watts, James Herriman, Jack Grubbs, Wayne Arnold, Tommy Prince, Ray Copper, Roger Johnson, Ken Bynum, Linda Welch, Heidi Snively, James Lewis, Steve Wilkerson, Greg Burt, Lloyd Rogers, Mike Purnell, Christa Herron, Mike Tripp, NASA/MSFC Environmental Test Lab, Robert W. Smith, and Operation Center for their help in preparation and operation of the test facility.

CONTENTS

ILLUSTRATIONS

TABLES

1.0 INTRODUCTION

The Advanced X-ray Astrophysics Facility - Imaging (AXAF-I) Instrument Cables Pre-bake and NASA/MFSC 1238 SPEC Certification was conducted in the Arnold Engineering Development Center (AEDC) 4x10 Thermal Vacuum Chamber and 7V Antechamber, respectively. The flight hardware instrument cables provide the connections to the satellite's sensors and on-board process modules. The instrument cables certified included coaxial, multi-conductor, thermocouple wires, BNC connectors, limit switches, and several other miscellaneous connector devices.

The primary objective of these tests was to de-contaminate/certify cleanliness of the instrument cables developed under the NASA-MSFC AXAF-I program. The NASA/MSFC 1238 Specification certification was performed in two steps. First, all cables were pre-baked at 200°F for a minimum of 72 hr and a maximum of 100 hr with a vacuum level of less than 1E-5 torr. The pre-bake test was performed in AEDC's 4x10 Thermal Vacuum Chamber. Upon completion, the cables were placed in AEDC's 7V Antechamber and certified at 160°F with a vacuum level less than 1E-6 torr until the TQCM obtained less than 1 Hz/hr rate of change for 12 hr and further exposing an Optical Witness Sample (OWS) for 24 hr. The cables were not considered certified until the OWS passed a contaminate reflection test at NASA/MSFC. All chamber housekeeping and test article data were acquired by AEDC.

This report does not include all the data obtained during the tests but describes the particulars of each test phase and presents some typical results from each phase. The equipment used to accomplish the test objectives is also discussed. All the OWS from the test program were transported and certified by NASA/MFSC Contamination Laboratory at the time of each cable certification completion.

2.0 APPARATUS

2.1 4x10 THERMAL VACUUM CHAMBER

The 4x10 Thermal Vacuum Chamber, located in the Space Systems Research Laboratory at Arnold Air Force Base, TN, was designed for general purpose testing of components and space vehicles. The chamber is nominally a 4-ft-diam by 10-ft long horizontal test chamber. Its vacuum shell is constructed of stainless steel and is normally equipped with LN_2 /GHe cooled liners (77K/10K) to simulate the thermal environment of space. The pre-bake test did not require any cryogens, therefore all liners were removed prior to test to allow for more bake-out liner area. The working volume within the chamber is nominally 40-in. in diameter by 10 ft in length.

Personnel access to the 4x10 chamber is through three 4-ft-diam bulkheads opening in the west side, north, and south ends of the chamber. All AXAF-I instrument cables were installed and removed though the north end of the chamber.

2.1.1 4x10 PUMPING SYSTEM

The chamber is evacuated with a combination of vacuum pumping components which includes a 90 cfm roughing pump and a 1,500 liter/sec turbomolecular pump (Fig. 1) and a separate 10-in. helium cryopump system (CVI-TMP250), Fig. 2. Each pumping system has an individual isolation valve with a safety interlock system that automatically isolates the vacuum pumping systems from the chamber in case of power, air, or cooling water failure and/or if the turbopump foreline pressure exceeds normal operational limits.

During the pre-bake tests, the chamber was initially evacuated with the turbomolecular pumping system. After the pre-bake test temperature and chamber pressure requirements were met, the turbomolecular pumping system was isolated from the chamber and the cryopump (cooled to 12K) was brought on-line. The cryopumping system provided additional safety for clean/non-contaminate pumping on the chamber. The cryopumping system is not used in the initial pumpdown because the cryosurfaces would be overloaded and decrease the efficiency of the pump. Chamber pressures from 1.4×10^{-6} torr to 5.1×10^{-6} torr were obtained during all five of the pre-bake tests.

2.1.2 4x10 BAKEOUT LINER

The bakeout liner consisted of four 6061 aluminum 2-ft x 8-ft x 1/4-in. panels welded together forming a rectangular box with two 6061 aluminum 2-ft x 2-ft x 1/4-in. panels mounted on the ends. Two-inch spacers were placed between both end panels and the constructed box to allow molecular flow. A 304 stainless steel 2-ft by 8-ft x 1/2-in. frame with stainless steel 1/2-in. screen mesh was constructed and used to slide the test articles in and out of the chamber. Each panel side had six equally spaced T-3 240V 1000-W infrared lamps which were mounted using Teflon® posts for the lamp holders and a common bare copper wire (both sides) for conductors. Two lamps were placed on the end panels. All lamp circuits were placed in a parallel configuration. Voltage and current measurements were made on each lamp prior to testing to elimate any non-uniformities. All panels were covered with a 6061 aluminum 1/16-in. thick reflector shield to enhance the lamps heating efficiency.

2.1.3 4x10 CHAMBER AREA

An 8-ft wide by 8-ft deep by 10-ft tall portable clean room was attached to the north end of the 4x10 chamber where the cables could be installed and removed in a Class 1000 clean room environment (Fig. 3). Limited chamber personnel with appropriate clean room attire were employed to maintain consistent cable handling procedures. A clean room bag sealer was placed in the portable clean room tent allowing the pre-baked cables to be double bagged upon each pre-bake completion. Two different bagging materials, supplied by NASA/MSFC, were prepared using the sealer during chamber repressurization. The cables were removed and bagged at elevated temperatures, approximately 100° to 125°F, and transported to the 7V Class 1000 clean room.

2.2 7V ANTECHAMBER

The 7V Antechamber is an extension of the 7V Sensor Test Chamber. The 7V Antechamber was specifically designed for mission scene calibration testing of IR sensor systems. The antechamber normally houses the sensor system test hardware. The antechamber (Fig. 4) is nominally a 7-ft-diam by 8-ft length horizontal test chamber. The vacuum shell is constructed of 6061 aluminum, and it is equipped with slide rails to allow a sensor system or optical bench to be rolled into the chamber.

Access to the 7V Antechamber is through a 7-ft-diam bulkhead on the east end of the chamber. A 7-ft-diam spool piece, located at the west end of the chamber, provides the chamber interface to vacuum pumping system. All test articles were installed and removed through the east 7-ft-diam bulkhead with an overhead hoist.

2.2.1 7V ANTECHAMBER PUMPING SYSTEM

The chamber was evacuated in stages with a combination of vacuum pumping components which includes a 140 cfm roughing pump, three 100 cfm diaphragm pumps, one 360 liter/sec turbomolecular pump (Fig. 5) and two CVI-TMP250-10-in. cryopumps (Fig. 6). All mechanical pumps were isolated with three independent LN_2 cooling baffles to prevent backstreaming. Safety system interlocks automatically isolated the vacuum pump systems from the chamber in case of power, air, or cooling water failure or if the turbopump foreline pressure exceeded normal operating limits.

During the certification tests, the chamber was initially evacuated with the turbomolecular pumping system. After the certification test temperature and chamber pressure requirements were met, the turbomolecular pumping system was isolated from the chamber and two 10-in. gaseous helium cryopumps (cooled to 12K) were brought on-line. The cryopumping system provides an additional safety level for clean/non-contaminate pumping on the chamber. The cryopumping system is not used in the initial pumpdown because the cryosurfaces would be overloaded and decrease the efficiency of the pump. The cryopumps were visually shielded from the test volume to eliminate line-of-sight cooling (Fig. 7). Chamber pressures from 0.7×10^{-7} torr to 3.1×10^{-7} torr were obtained during all of the 1238 specification certification tests.

2.2.2 7V ANTECHAMBER HEATING SYSTEM

A 4-ft by 8-ft by 1/4-in. 6061 aluminum sheet (table) was placed on the 7V Antechamber slide rails and supported the test articles during certification. Two 7-ft long by 3-ft tall lamp arrays were mounted 3 ft apart on each side of the chamber table. Each lamp array consisted of six T-3 240V 1000-W infrared lamps, in parallel, tied to a bare copper bus bars, as shown in Fig. 8.

2.3 TEST ARTICLE

The instrument cables to be certified included coaxial, multi-conductor, thermocouple wires, BNC connectors, limit switches, and several other miscellaneous connector devices. A cable inventory with certification priority is listed in Table 1.

2.4 TEST SPECIFIC HARDWARE

A 1-MHz Thermal Electric-cooled Quartz Crystal Microbalance (TQCM) and an Optical Witness Sample (OWS) were mounted to copper heat sinks (water-cooled) in the 7V Antechamber. Both TQCM and OWS were mounted with a large field of view directly at the entire cable assemblies (Fig. 9). An instrumentation feedthrough port was modified by adding four ¼-in. AN-fittings for water cooling lines, two supplies and two returns. A NesLab RTE-4000 water heater/chiller circulator was used for the OWS copper heat sink allowing temperatures from 50° to 196°F to be maintained (Fig. 10). A NesLab RTE-100 water heater/chiller circulator was used for the TQCM copper heat sink allowing 68°F to be maintained (Fig. 10).

2.5 TEST INSTRUMENTATION

2.5.1 4x10 THERMAL VACUUM CHAMBER INSTRUMENTATION

A Kaye Instruments Digi 4S data logger with a 16 channel multiplexer was used to measure the chamber housekeeping data. The data logger output was sent and stored on a personnel computer (PC). The log interval was 5 min. All test data files were backed-up on 3-1/2-in. floppy disks. Instrumentation was provided to measure vacuum levels and surface temperatures.

Chamber vacuum was measured, depending on the vacuum level, using two Pirani/convectron vacuum gages and three Bayard-Alpert ionization gages. All vacuum gage outputs were computer logged and manually recorded in the test operation log book. Bayard-Alpert gauges were mounted on the chamber's east side turbopump foreline, top-south end, and the top-north end. Convectron gauges were mounted on the chamber's eastside turbopump foreline and top-north end. Chamber pressures measured ranged from 1.1×10^{-6} torr to 5.1×10^{-6} torr during the five pre-bake pumpdowns.

Panel surfaces and test article temperatures were measured using Teflon insulated type T (copper/constantan) thermocouples that were read by the data logger. The data logger converted the thermocouple output voltages to temperatures displayed in degrees Fahrenheit. Each side panel (zone) had three thermocouples mounted inside the test volume which were averaged and fed to a lamp zone controller. Each end panel (zone) had one thermocouple mounted inside the test volume and fed to a lamp zone controller. A type T jumper wire from the controllers to the data system provided recorded information. Figure 11 shows the Kaye data system, lamp controllers and the chamber pump system controls. Table 2 identifies the data logger channel assignments. Each thermocouple location on the test chamber was verified by spraying the thermocouple junction with a "Freeze Mist II" solution for a temperature response.

To minimize the effects of any possible power interruptions on tests (particularly on the long term stability tests), all chamber pumping systems are powered from uninterruptible power supply capable of delivering up to 50 kW.

A calibration was made on the data system by dipping a temperature sensor in an ice bath and with a calibrated voltage standard representing the elevated temperatures. A major potential source of error with temperature sensors is from poor thermal contact. To avoid such problems and others, all thermocouples were attached with a Bellville washer to provide a spring loaded contact. All critical thermocouples had a backup in case of an open or break loose condition. The data logger had a ± 0.1 °F resolution.

2.5.2 7V ANTECHAMBER TEST INSTRUMENTATION

The instrumentation for the 7V Antechamber was similar to the 4x10 chamber. However, the pressure in the chamber was measured with only one Bayard-Alpert ionization gauge and ranged from 0.7×10^{-7} torr to 3.1×10^{-7} torr during the three certification pumpdowns. Bayard-Alpert gauges were mounted on the chamber's

turbopump foreline, south side, and north side. The north side gage was used to log the chamber pressure. The south and turbopump gages served as backups.

All test article temperatures were measured using copper/constantan thermocouples that were read by a multi-channel data logger. The data logger converted the thermocouple outputs voltages to temperatures displayed in degrees Fahrenheit. Three Teflon coated thermocouples were mounted to a paper clip which was attached to the test articles. Two thermocouples provided a feedback to the lamp controllers. Figure 12 shows the lamp control system for the 7V Antechamber. Table 3 identifies the data logger channel assignments. Each thermocouple location on the test chamber was verified by spraying the thermocouple junction with a "Freeze Mist II" solution for a temperature response.

To minimize the effects of any possible power interruptions on tests (particularly on the long term stability tests), all chamber pumping systems are powered from uninterruptible power supply capable of delivering up to 50 kW.

3.0 PROCEDURE

3.1 4X10 THERMAL VACUUM CHAMBER BAKEOUT

Extreme attention was paid to cleaning and limiting the materials introduced into the 4x10 chamber. All chamber ports were removed and wiped down twice with isopropyl alcohol (reagent grade). The chamber and port flanges were also wiped down twice with alcohol. The pre-bake box and reflector shields were dipped in an acid bath and wiped down with alcohol before assembly and alcohol wiped after assembly. All lamps, mounting posts, screws, connectors, thermocouple cables, and lamp power cables were wiped down with alcohol. All flange o-rings were replaced and lightly greased with, "NASA - approved for use," Apiezon "L." The 4x10 chamber and all materials in the chamber were baked-out for one week prior to the pre-bake tests at 250°F. A thorough helium leak test on the 4x10 chamber was performed during the bakeout.

3.2 4X10 PRE-BAKE TESTS

The pre-bake vacuum test approach consisted of exposing flight hardware cables to less than 1E-5 torr pressure with a 200°F uniform thermal background for a minimum of 72 hr but not exceeding 100 hr. For each pre-bake test, the cables were loosely laid on a 304 stainless steel screen and slid into the chamber. The pre-bake testing was broken into five separate pumpdowns to eliminate cable overlapping in order to maximize the surface area outgassing. Upon pre-bake completion, the chamber was repressurized with bone dry nitrogen and the cables were removed, inventoried, double-bagged, and then transported to the 7V clean room. A summary of the pre-bake pumpdowns are shown in Tables 4-8.

3.3 7V ANTECHAMBER 1238 SPECIFICATION CHAMBER CERTIFICATION

Prior to the 1238 specification chamber certification, the chamber was wiped down with alcohol, and the TQCM and OWS were installed. The OWS cover plate was removed just prior to the chamber closeout. The 1238 specification chamber certification test approach consisted of exposing the chamber to less than 1E-6 torr pressure and a 160°F uniform thermal background until the 15-MHz TQCM was reading less than or equal to 1 Hz/hr rate of change for 36 hr. During that time, the OWS temperature was set at 178°F (18°F above flight hardware temperature) and the TQCM heat sink was set at 68°F. The TQCM oscillator crystal temperature was set at 10°C.

The software provided by NASA-MSFC, "PACRATS," was used to monitor the TQCM readings. After the 1 Hz/hr rate of change for 36 hr was met, the chamber was maintained at 160°F and the OWS was lowered to 50°F for 24 hr. Upon completion, the lamps were turned off and the OWS was slowly raised to 85°F. The chamber was then repressurized slowly with bone dry nitrogen until the bulkhead was opened and the OWS was covered and transported to NASA-MSFC for verification.

3.4 7V ANTECHAMBER 1238 SPECIFICATION CABLE CERTIFICATION

Prior to the 1238 specification cable certification, a new OWS was installed. The OWS cover plate was removed just prior to the chamber closeout. The 1238 specification chamber certification test approach consisted of evacuating the chamber to less than 1E-6 torr pressures and heating the cables to 178 ° (18°F above flight hardware temperature) until the 15-MHz TQCM was reading less than or equal to 1 Hz/hr rate of change for 36 hr. During that time, the OWS temperature was set at 196 °F (18°F above cable temperature) and the TQCM heat sink was set at 68°F. The TQCM thermal electric cooler was set at 10°C. The software provided by NASA-MSFC, "PACRATS," was used to monitor the TQCM readings. After the 1 Hz/hr rate of change for 12 hr was met, the chamber and cables were lowered to 160°F. The TQCM crystal was maintained at 10°C and the OWS was lowered to 50°F for 24 hr. Upon completion, the lamps were turned off and the OWS was slowly raised to 85°F. Then, the chamber was repressurized slowly with bone dry nitrogen until the bulkhead was opened and the OWS was covered and transported to NASA-MSFC for verification. The chamber was kept under a positive bone dry nitrogen purge until NASA-MSFC reported verification met. The cables were individually inventoried when removed and double bagged for shipment back to NASA-MSFC.

For each 1238 specification cable certification test, the cables were loosely laid on a 304 stainless steel screen and slid into the chamber. The certification testing was broken into two separate pumpdowns to prevent any cable overlapping. A summary of the 1238 specification cable certification pumpdowns is shown in Tables 9-10.

While AEDC continued 1238 specification cable certification for two of five potential loads, NASA-MSFC laboratory had chambers become available. NASA-MSFC retrieved the remaining cables and completed the certifications.

4.0 RESULTS AND DISCUSSION

4.1 DATA PRESENTATION

Within each hardware configuration, the tests were conducted in the order that best used the test time available. For reference, Tables 4-11 list all of the tests conducted and give the date when each was run and which hardware configuration and heater settings applied was involved. The final decision of certification was determined by NASA-MSFC Contamination Laboratory. The results for all the 1238 specification certifications performed at AEDC attained a "passed" status. AEDC received verbal recommendation to proceed from the AXAF manager. Therefore, this report does not contain any certification documentation.

4.2 4X10 THERMAL VACUUM CHAMBER PRE-BAKE TEST #1

Three flight hardware cables with connectors were loaded onto the 304 stainless steel screen. These cables were mostly 61 wire shielded Teflon coated wires at various lengths. The minimum chamber pressure reached was 2.3E-6 torr during test. The cables took approximately 18 hr to reach the 200°F temperature requirement. The cables were baked for 73.8 hr. Upon pre-bake completion, the cables were removed while hot and double bagged, inventoried, and transported to the 7V 100 class clean room. All test procedures and events of the test chamber and test article during the pre-bake test #1 were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

4.3 4X10 THERMAL VACUUM CHAMBER PRE-BAKE TEST #2

Five flight hardware cables with connectors were loaded onto the 304 stainless steel screen. These cables were mostly 61 wire shielded Teflon coated wires at various lengths. The minimum chamber pressure reached was 1.8E-6 torr during test. The cables were baked for 91.2 hr. Upon pre-bake completion, the cables were removed while hot and double bagged, inventoried, and transported to the 7V 100 class clean room. All test procedures and events of the test chamber and test article during the pre-bake test #2 were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

4.4 4X10 THERMAL VACUUM CHAMBER PRE-BAKE TEST #3

Seven flight hardware cables with connectors were loaded onto the 304 stainless steel screen. These cables were mostly 61 wire shielded Teflon insulated wires at various lengths. The minimum chamber pressure reached was 2.0E-6 torr during test. The cables were baked for 73.4 hr. Upon pre-bake completion, the cables were removed while hot, double bagged, inventoried, and transported to the 7V 100 class clean room. All test procedures and events of the test chamber and test article during the pre-bake test #3 were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

4.5 4X10 THERMAL VACUUM CHAMBER PRE-BAKE TEST #4

One multi-conductor cable, several coaxial cables, 12 SHV connectors, and 35 BNC connectors were loaded onto the 304 stainless steel screen. These cables were mostly wire shielded Teflon coated wires at various lengths. The minimum chamber pressure reached was 1.6E-6 torr during test. The cables were baked for 81.0 hr. Upon pre-bake completion, the cables were removed while hot, double bagged, inventoried, and transported to the 7V 100 class clean room. All test procedures and events of the test chamber and test article during the pre-bake test #4 were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

4.6 4X10 THERMAL VACUUM CHAMBER PRE-BAKE TEST #5

The remainder of the coaxial flight hardware cables with connectors, 4 LEDs/transmitters with thermocouples were loaded onto the 304 stainless steel screen. These cables were mostly wire shielded Teflon coated wires at various lengths. The minimum chamber pressure reached was 1.4E-6 torr during test. The cables were baked for 89.0 hr. Upon pre-bake completion, the cables were removed while hot, double bagged, inventoried, and transported to the 7V 100 class clean room. All test procedures and events of the test chamber and test article during the pre-bake test #5 were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

4.7 7V ANTECHAMBER 1238 SPECIFICATION CHAMBER CERTIFICATION

Every item, except for the test articles, was present in the chamber during the initial chamber bakeout and certification. After baking out the 7V Antechamber for several days, the TQCM at 10°C was maintaining a 50 Hz/hr rate of change for over 36

hr and did not seem to vary. The chamber pressure was at 3.3x10-7 torr which was quoted as being better than what currently ran at NASA/MSFC laboratory. Randy Stevens from NASA/MSFC had seen this before and recommended isolation of the water cooling lines in case of leaks. Immediately the rate of change reduced from 50 Hz/hr to 10 Hz/hr and by the next morning less than 1 Hz/hr was displayed. After opening the chamber, the water lines were leak checked and pressurized, which verified a pin hole leak in the TQCM heat sink. Upon certification approval, a new OWS and the first load of cables were installed in the chamber for certification run #1. All test procedures and events of the test chamber and test article during the chamber certification were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

4.8 7V ANTECHAMBER 1238 SPECIFICATION CABLE CERTIFICATION #1

Six flight hardware cables with connectors were loaded onto the 304 stainless steel screen. These cables were mostly 61 wire shielded Teflon coated wires at various lengths. The minimum chamber pressure reached was 2.7E-7 torr during test. The OWS ID number was 89-96. The OWS exposure time was 24 hr and 30 min. Upon certification approval, the cables were removed, double bagged, inventoried, and shipped to NASA-MSFC AXAF personnel. A new OWS and new load of cables were installed into the chamber for certification run #2. All test procedures and events of the test chamber and test article during the chamber certification were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

4.9 7V ANTECHAMBER 1238 SPECIFICATION CABLE CERTIFICATION #2

Five flight hardware cables with connectors were loaded onto the 304 stainless steel screen. These cables were mostly 61 wire shielded Teflon coated wires at various lengths. The minimum chamber pressure reached was 2.2E-7 torr during test. The OWS ID number was 68-96. The OWS exposure time was 24 hr and 7 min. Upon certification approval, the cables were removed, double bagged, inventoried, and shipped to NASA-MSFC AXAF personnel. All test procedures and events of the test chamber and test article during the chamber certification were recorded and stored in the AEDC Project 2538 (Phase II) AXAF Test Log Book.

5.0 CONCLUDING REMARKS

Based on results of the AXAF-I operational tests, the following should be noted:

1. Lamps will overshoot in temperature if the multi-layer insulation (MLI) is used to insulate test cell from test liner. This is contributed to the lack of heat transfer due to MLI. To prevent overshooting, the lamps power was slowly ramped up until temperature requirements were met. No overshooting occured where MLI was not present.

2. The 7V Antechamber mass spectrometer showed water vapor as the main outgassing contaminate in the chamber. The 7V Antechamber is made of 6061 Aluminum, a material known for oxidation and water retention.

3. A 15-MHz TQCM is very sensitive to line-voltage interruptions and must be supplied by an uninterruptable power system.

4. A 15-MHz TQCM is very sensitive to temperature change. For example, a 2 Hz/hr rate change at 15°C can be as high or higher than 100 Hz/hr rate change at 10°C. Of course, the rate of change at a specific temperature is dependent upon the existing contaminates. The 7V Antechamber displayed similar characteristics prior to chamber bakeout.

5. Tiny pin hole leaks can still exist with chamber pressures down to 3.3x10-7 torr.

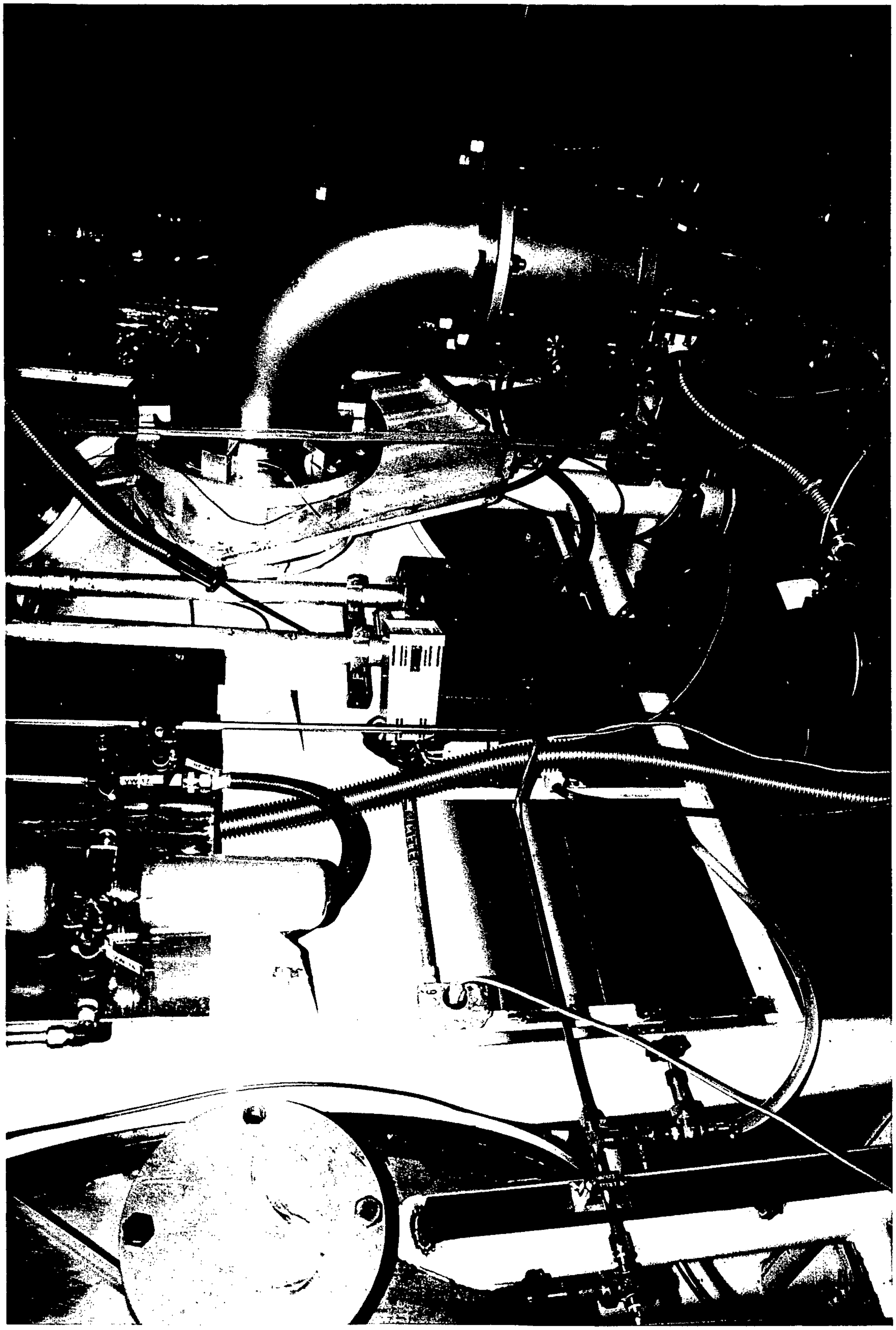

Figure 1. 4 x 10 Turbomolecular Pumping System.

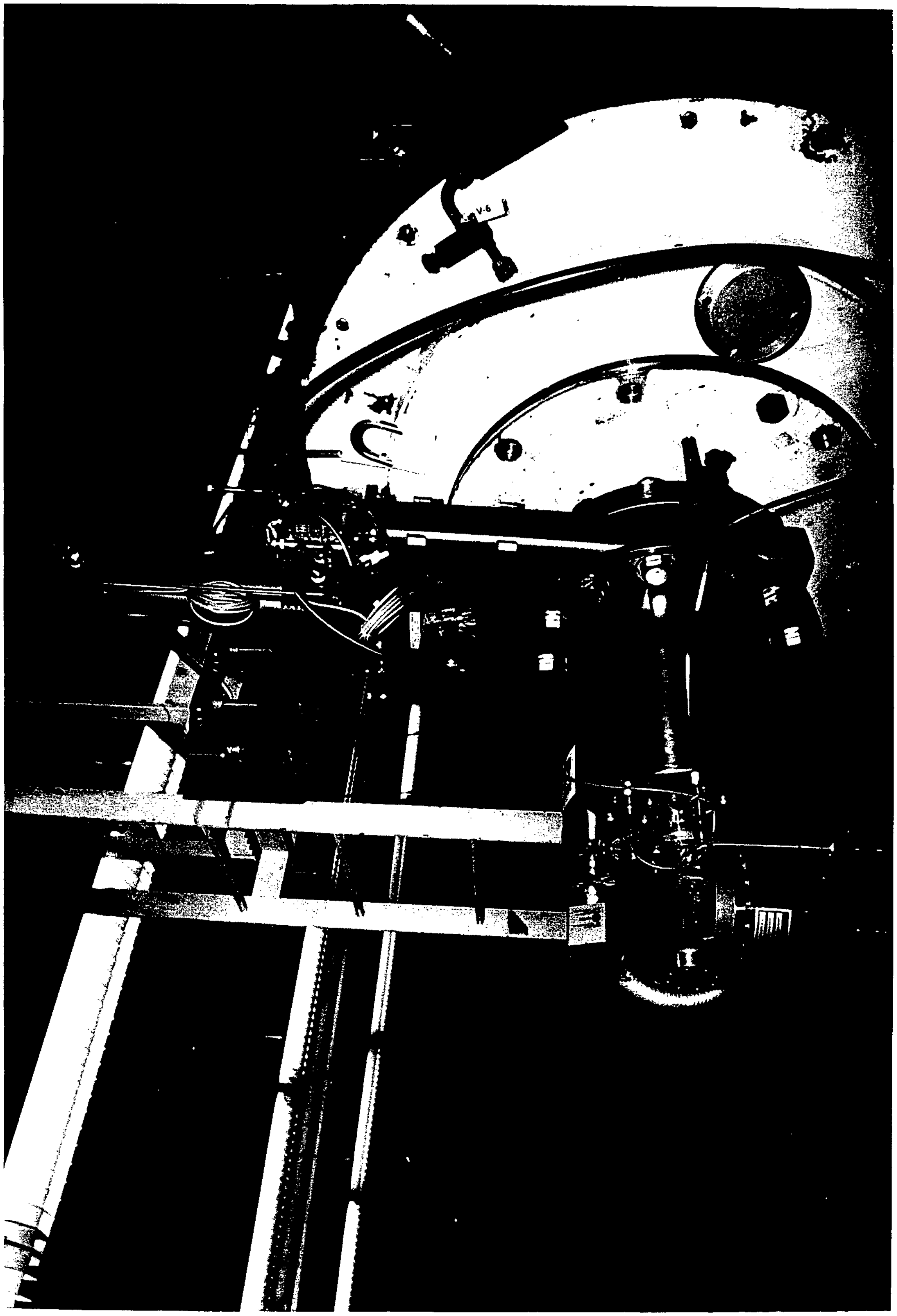

Figure 2. 4 x 10 GHe Pumping System.

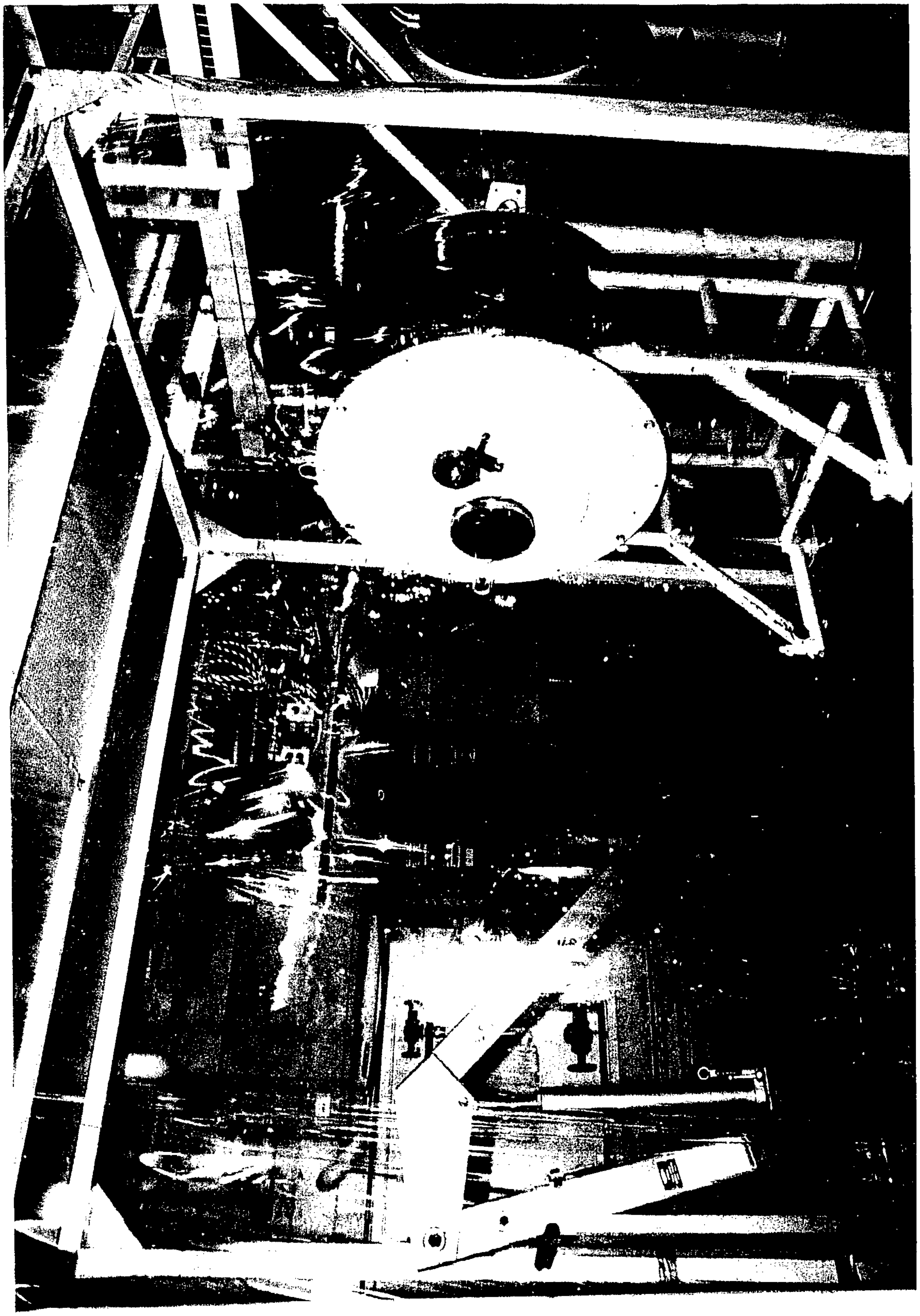

Figure 3. 4 x 10 Portable Clean Room Tent.

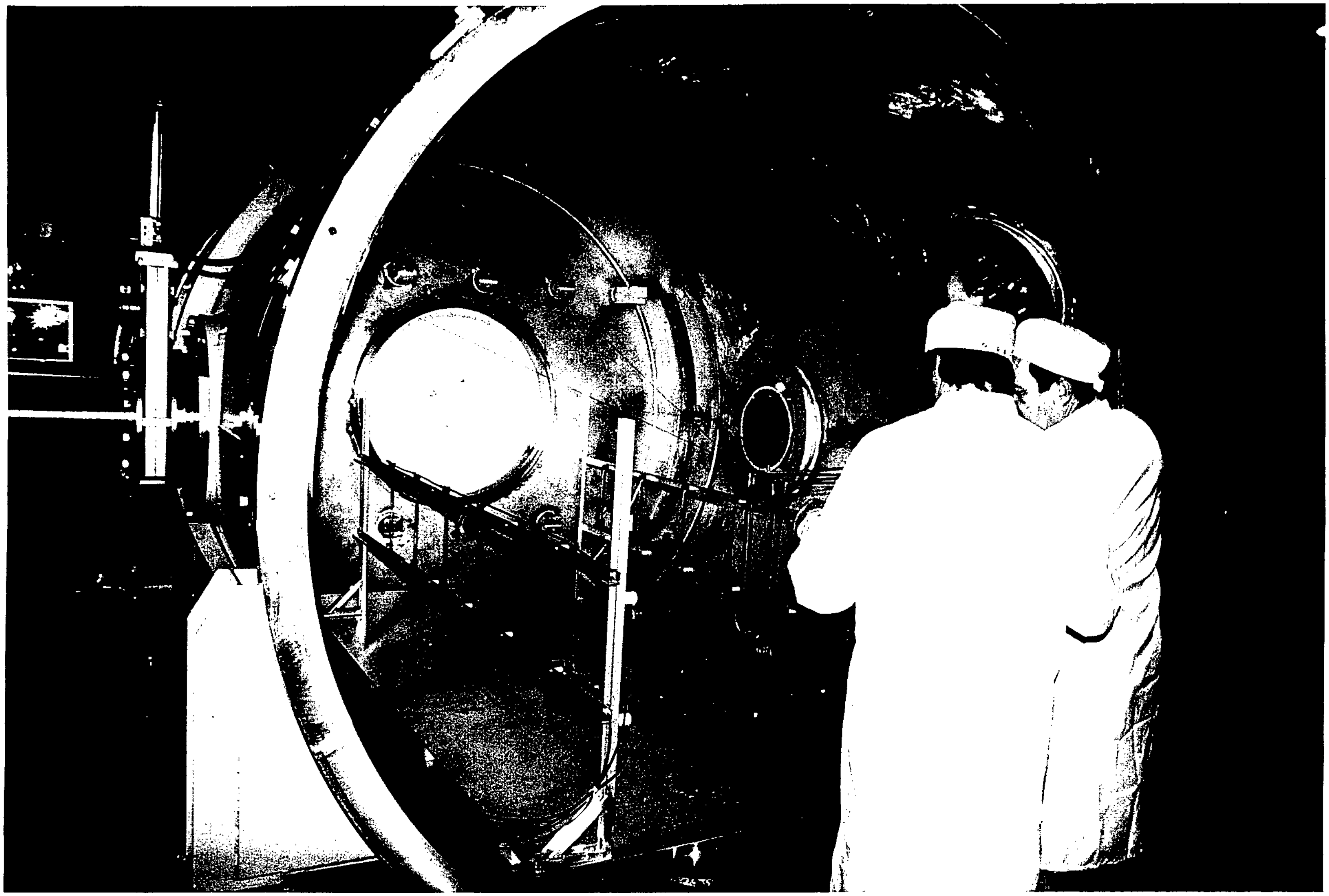

Figure 4. 7V Antechamber Vacuum Test Chamber.

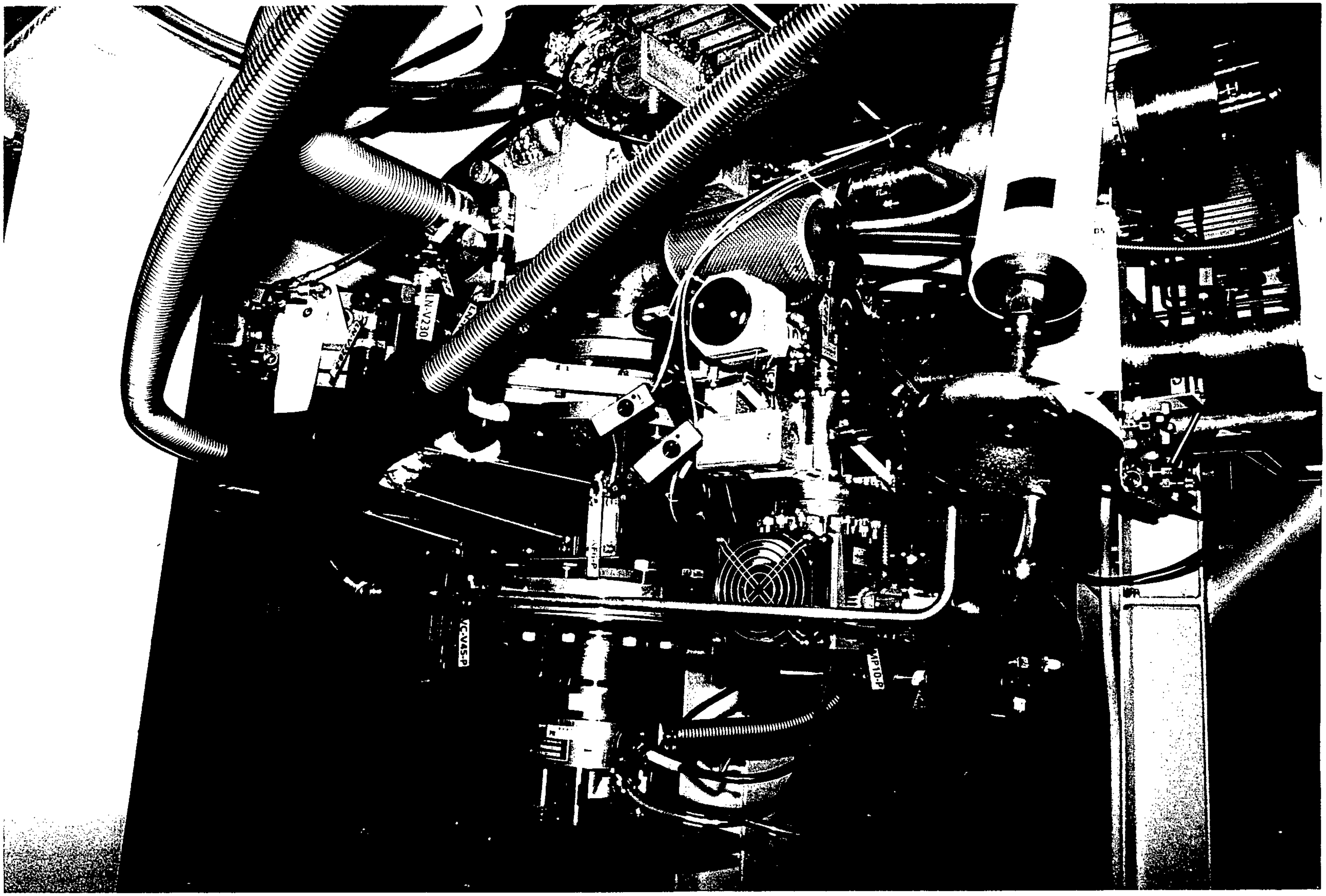

Figure 5. 7V Antechamber Turbomolecular Pumping System.

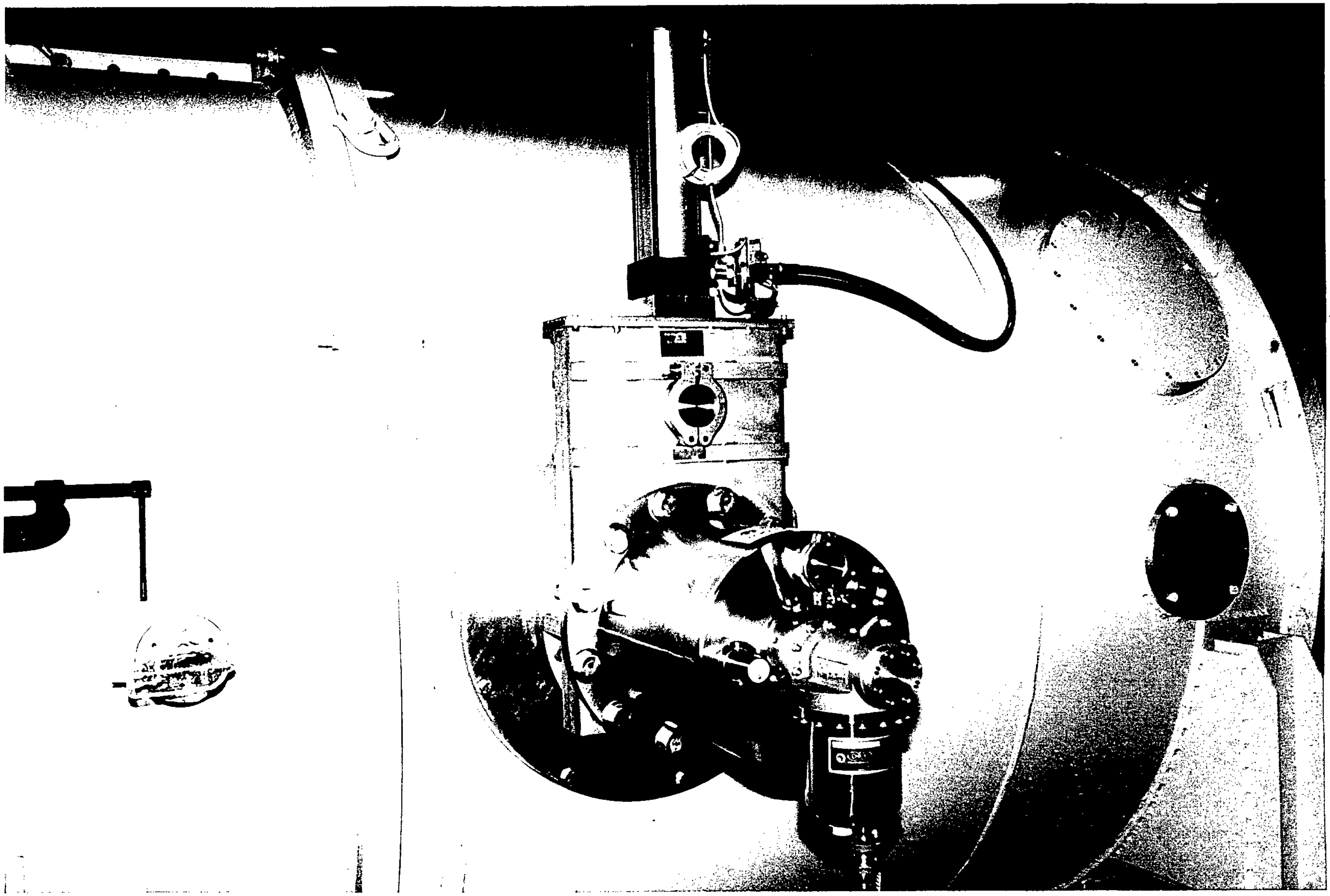

Figure 6. 7V Antechamber GHe Pumping System.

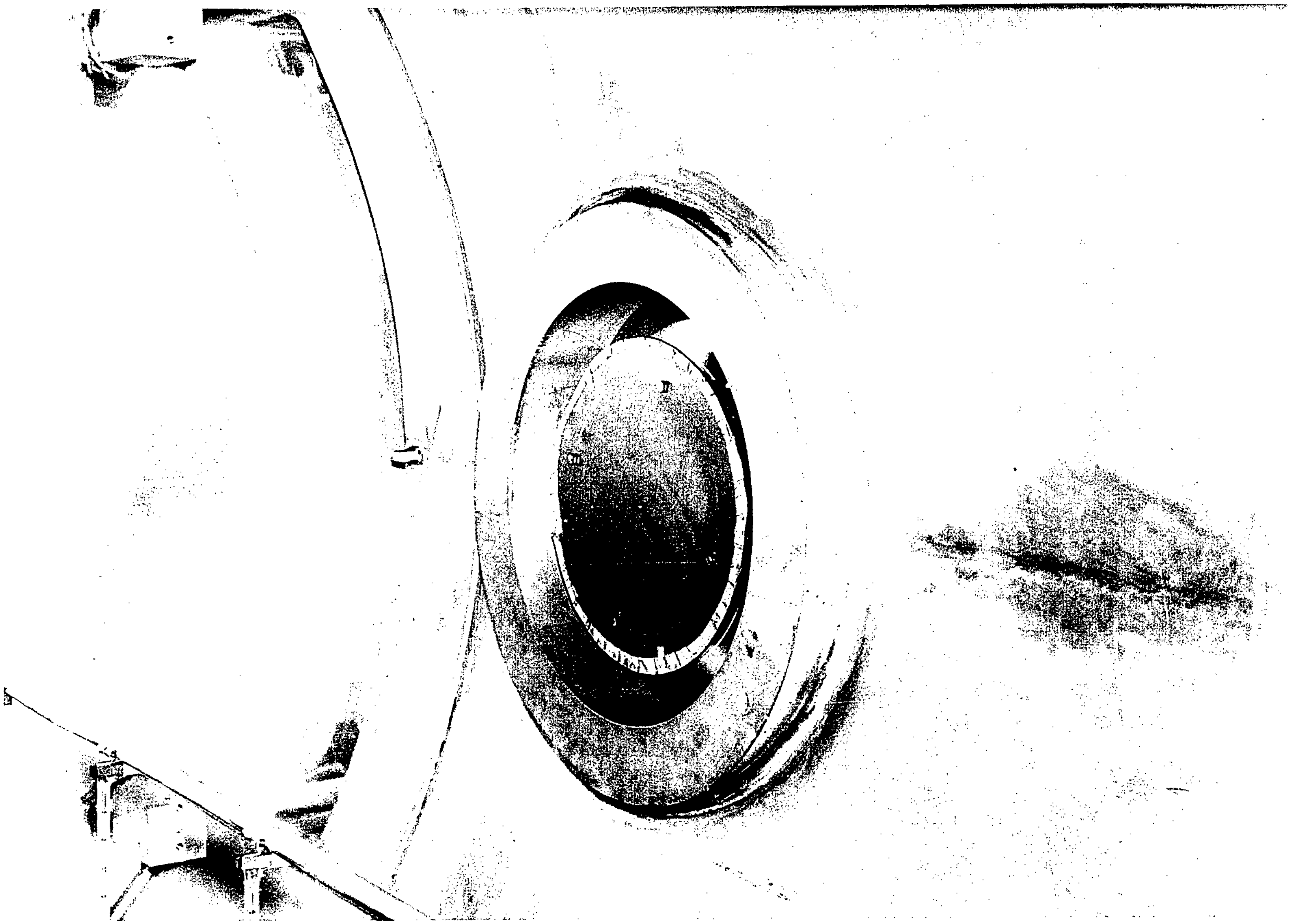

Figure 7. 7V Antechamber GHe Pumping System Shielding.

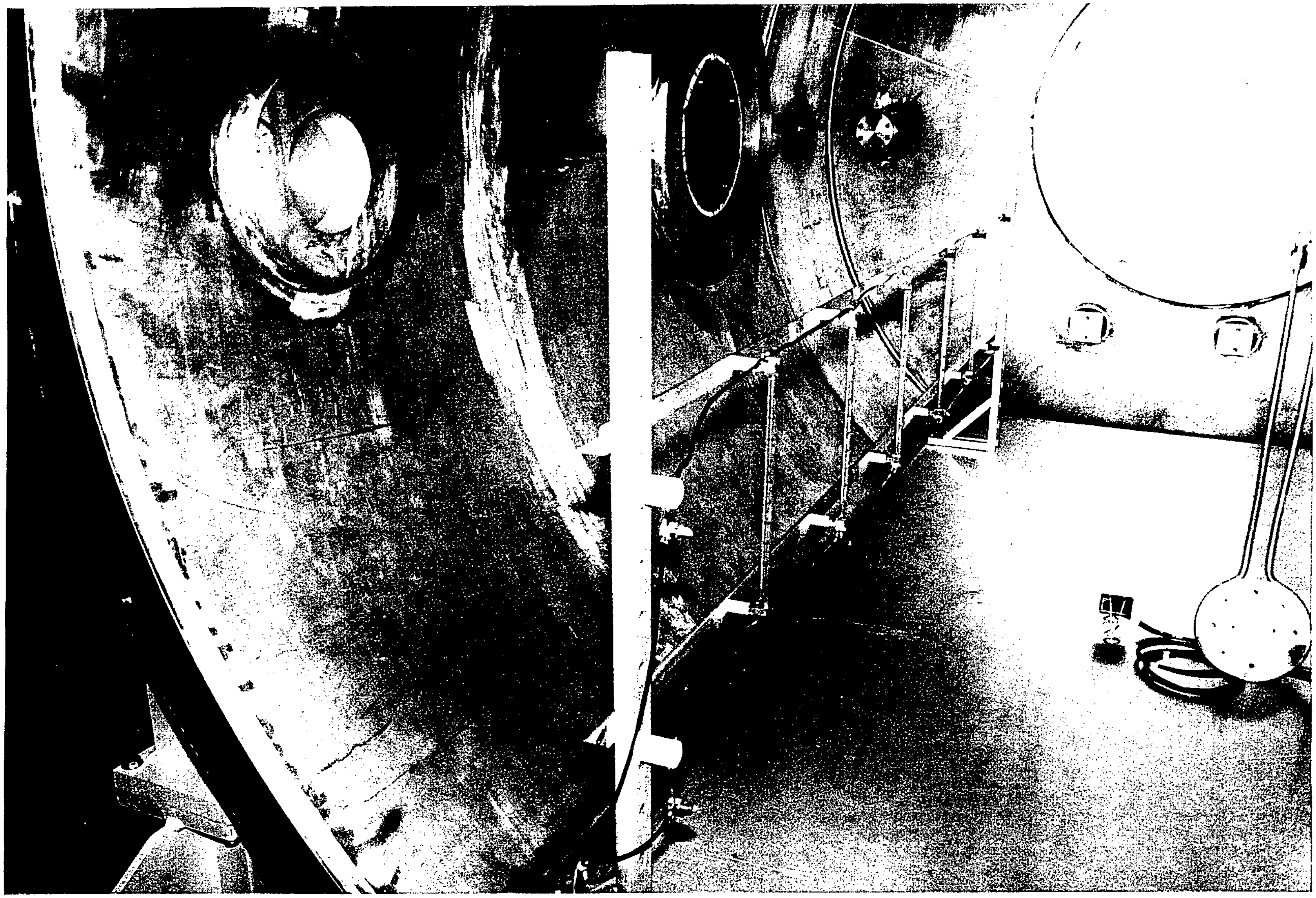

Figure 8. 7V Antechamber Lamp Array System.

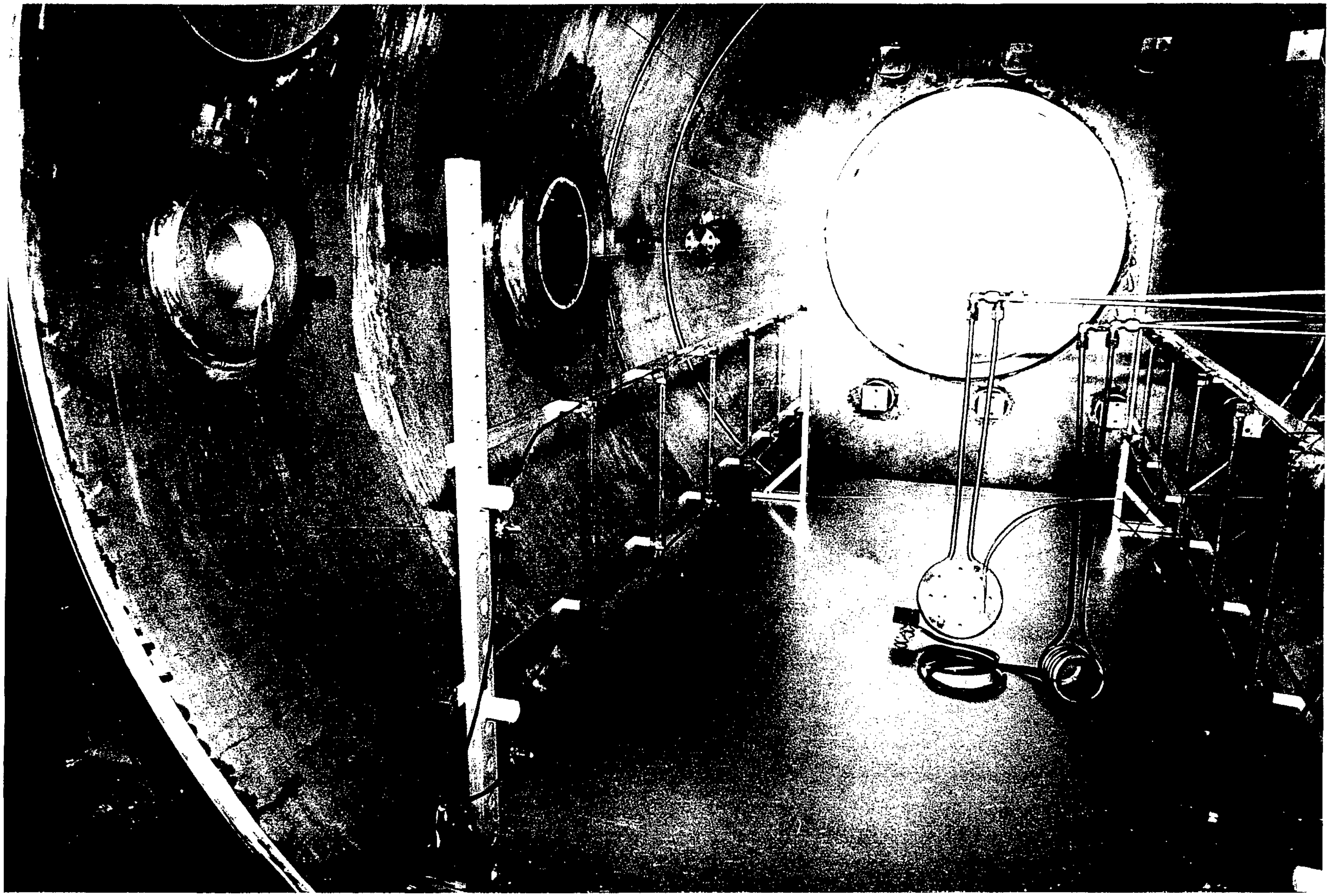

Figure 9. 7V Antechamber TQCM and QWS Field of View.

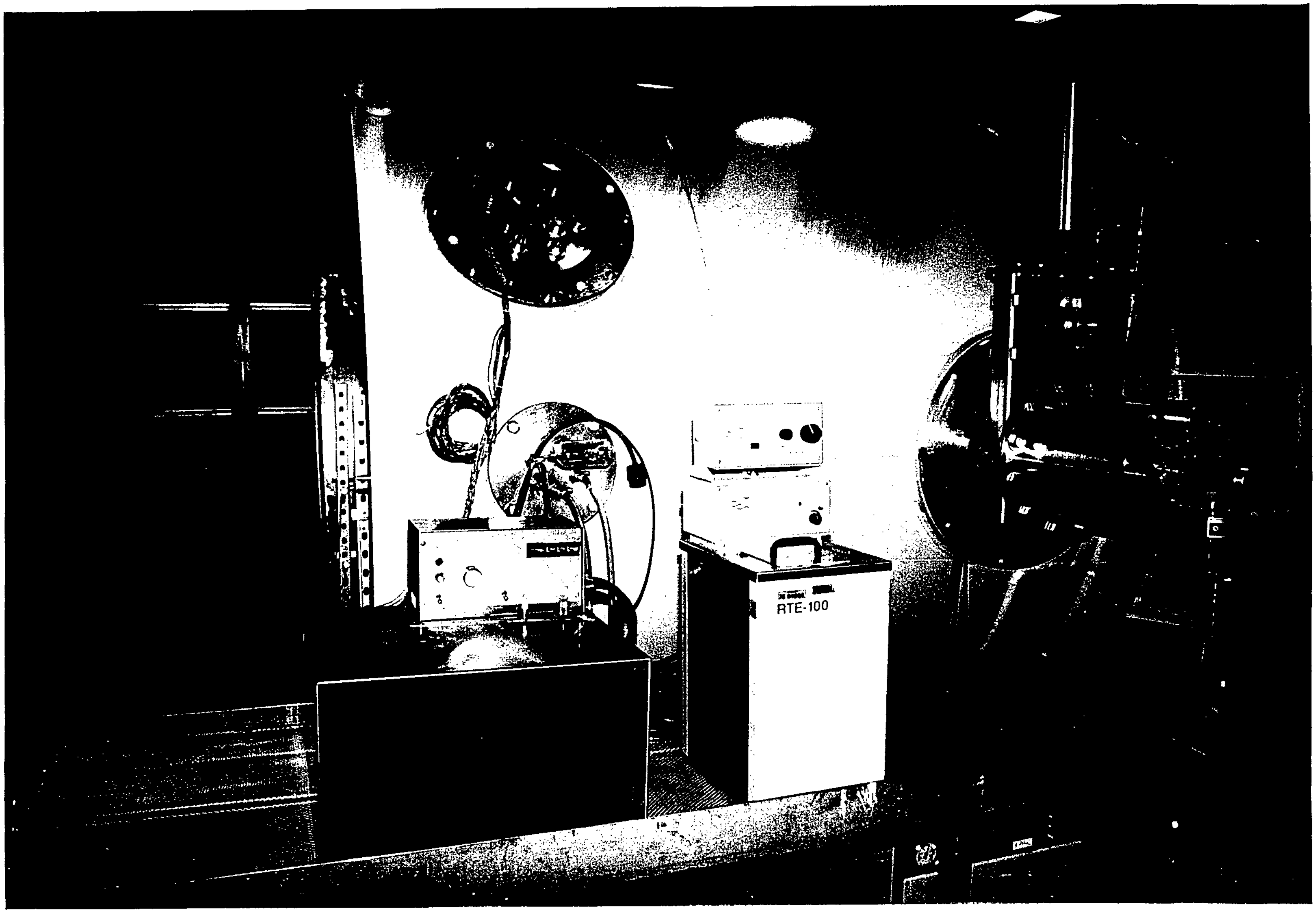

Figure 10. 7V Antechamber Water Heater/Cooling Systems.

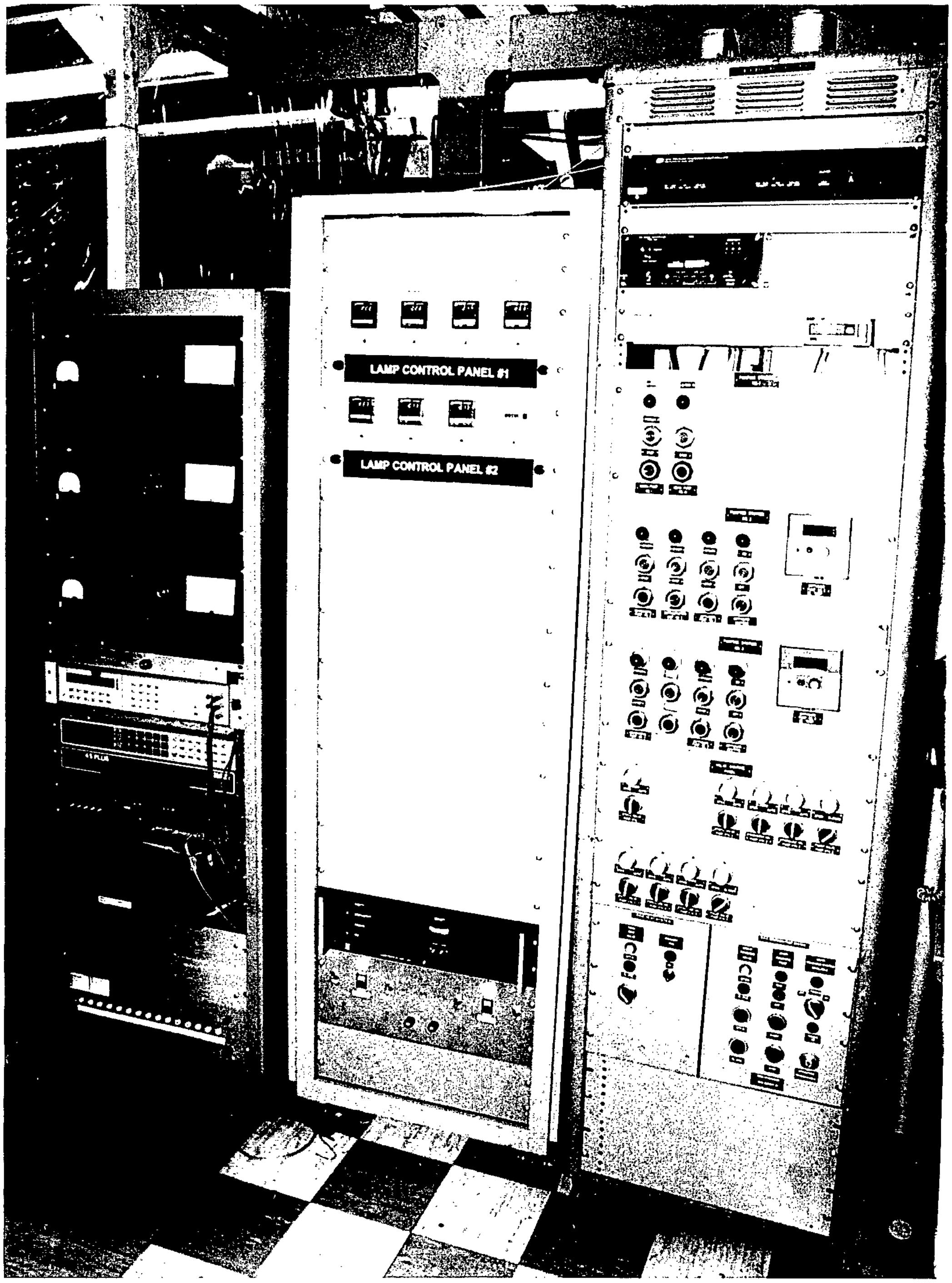

Figure 11. 4 x 10 Test Control Panels.

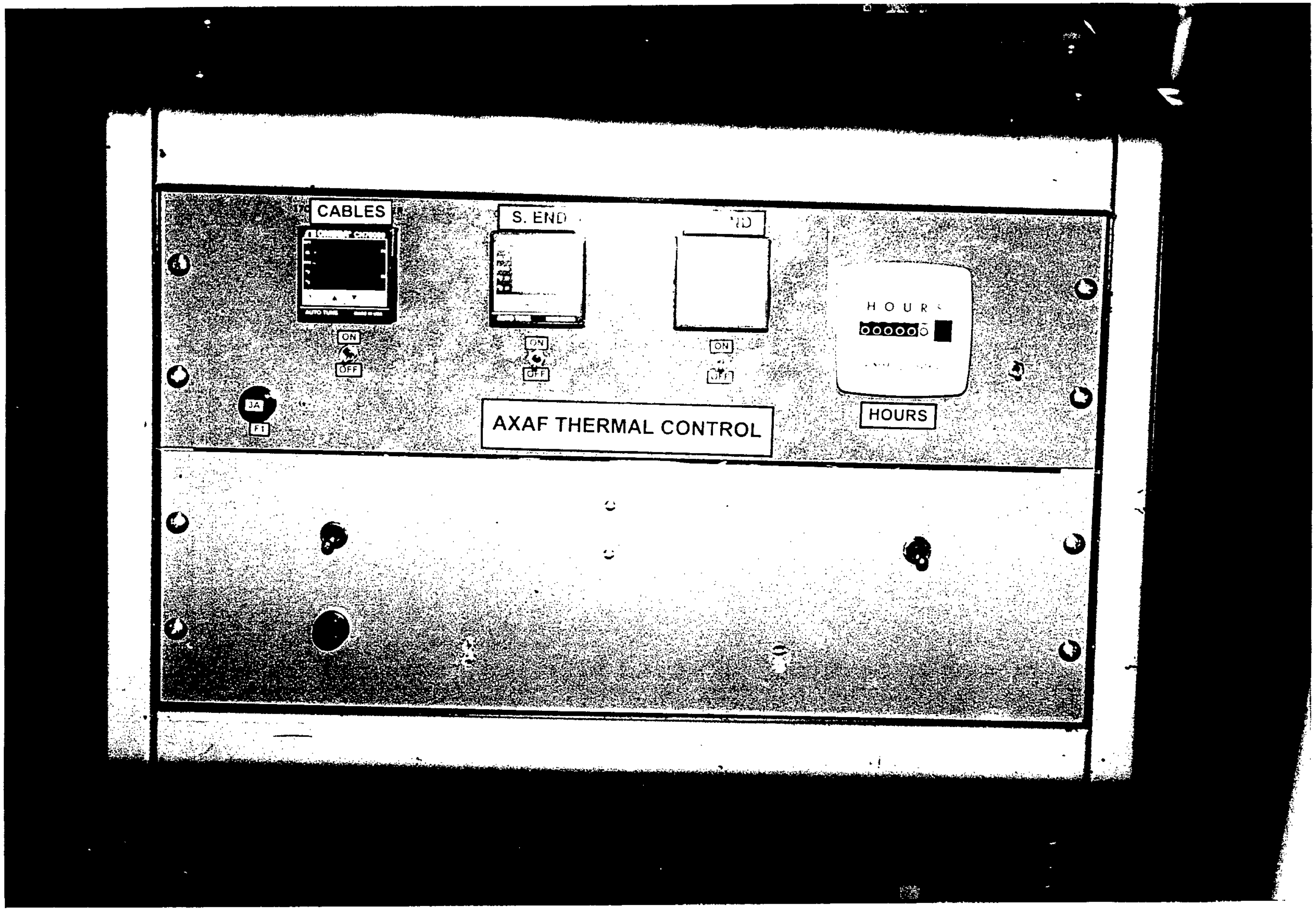

Figure 12. 7V Antechamber Lamp Control System.

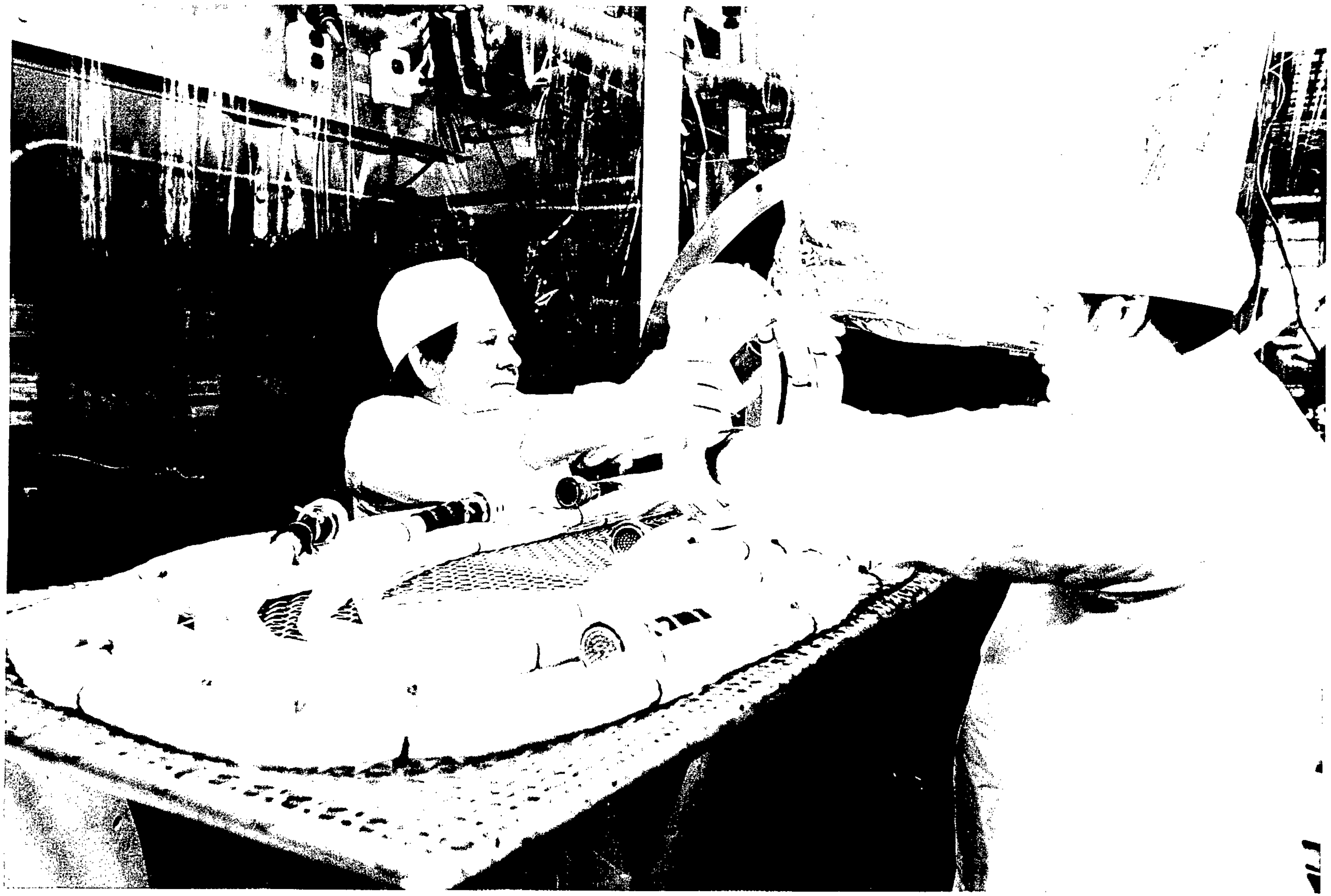

Figure 13. Loading Test Articles into 4 x 10 Test Chamber.

Table 1. Flight Hardware Inventory List

Priority #1	
HXDA Patch Panel Harness (includes WCV-352)	BNDH Patch Panel Harness (includes WMC-256)

Priority #2	
WMV 311	WMV 319
WMV 312	WMV 320
WMV 313	WMV 288
WMV 314	WMV 289
WMV 315	WMV 290
WMV 316	WMV 259
WMV 318	

Priority #3	
WCV 139	WCV 264
WCV 144	WCV 265
WCV 149	WCV 266
WCV 150	WCV 267
WCV 151	WCV 271
WCV 152	WCV 272
WCV 157	WCV 273
WCV 158	WCV 274
WCV 159	WCV 275-278
WCV 160	WCV 280-287
WCV 161	WCV 314-331
WCV 162	

Priority #4	
HXDS 5204	HXDS 5042 -1
HXDS 5319	HXDS 5042 -2
HXDS 1159-4	HXDS 5042 -3
HXDS 1159-5	HXDS 5042 -4
HXDS 1159-6	DS1 Led Assembly
HXDS 1159-7	DS2 Led Assembly
12 - BNC connectors	DS3 Led Assembly
35 - SHV connectors	DS4 Led Assembly

Table 2. 4x10 Kaye Channel Assignments

Channel	Description
Ch 1	North End Lamp Zone
Ch 2	Top Lamp Zone
Ch 3	East Side Lamp Zone
Ch 4	Bottom Lamp Zone
Ch 5	West Side Lamp Zone
Ch 6	South End Lamp Zone
Ch 7	Cables
Ch 8	Cables - Backup
Ch 9	Vacant
Ch 10	Ion Gage - North
Ch 11	Ion Gage - Top
Ch 12	Ion Gage - South
Ch 13	Convectron
Ch 14	Open
Ch 15	Open
Ch 16	Open

Table 3. 7V Antechamber Kaye Channel Assignments

Channel	Description
Ch 1	Cables
Ch 2	Cables
Ch 3	Cables
Ch 4	Cables
Ch 5	OWS Heat Sink
Ch 6	TQCM Heat Sink
Ch 7	Ion Gage South
Ch 8	Ion Gage North
Ch 9	spare
Ch 10	spare
Ch 11	spare
Ch 12	spare
Ch 13	spare
Ch 14	spare

Table 4. 4x10 Test Chamber Pre-bake #1

Pre-Bake Number:	1
Start Date:	5/7/96
Chamber Closeout Date/Time:	5/7/96 15:00 hrs
Data File:	AXAF1.prn
Start Clock Reading:	005.0 hr
Bake-out Temperature:	200°F
Cable ID Numbers:	HXDA Patch Panel Harness (includes WCV352) BNDH Patch Harness (includes WMV256) WMV159
Date/Time Completed:	5/11/96 11:00
Base Pressure:	2.32E-6 torr
End Clock Reading:	78.8 hr
Total Bakeout Time:	73.8 hr
Notes:	cables required 18:15 to reach 195°F

Table 5. 4x10 Test Chamber Pre-bake #2

Pre-Bake Number:	2
Start Date:	5/11/96
Chamber Closeout Date/Time:	5/11/96 14:28 hr
Data File:	AXAF2.prn
Start Clock Reading:	91.5 hr
Bake-out Temperature:	200°F
Cable ID Numbers:	HXDA WMV316 HXDA WMV315 HXDA WMV314 HXDA WMV319 HXDA WMV320
Date/Time Completed:	5/16/96 08:12
Base Pressure:	1.8E-6 torr
End Clock Reading:	182.7 hr
Total Bakeout Time:	91.2 hr
Notes:	everything worked nicely

Table 6. 4x10 Test Chamber Pre-bake #3

Pre-Bake Number:	3
Start Date:	5/16/96
Chamber Closeout Date/Time:	5/16/96 12:00 hrs
Data File:	AXAF3.prn
Start Clock Reading:	182.7 hr
Bake-out Temperature:	200°F
Cable ID Numbers:	HXDA WMV290 HXDA WMV288 HXDA WMV289 HXDA WMV313 HXDA WMV311 HXDA WMV312 HXDA WMV318
Date Completed:	5/16/96
Base Pressure:	1.99E-6 torr
End Clock Reading:	256.1 hr
Total Bakeout Time:	73.4 hr
Notes:	everything worked nicely

Table 7. 4x10 Test Chamber Pre-bake #4

Pre-Bake Number:	4
Start Date:	5/20/96
Chamber Closeout Date:	5/20/96
Data File:	AXAF4.prn
Start Clock Reading:	256.1 hrs
Bake-out Temperature:	200 degrees F
Cable ID Numbers:	HXDS 5204 (WMV159) HXDA WCV314 -WCV331 35 - BNC Connectors 12 - SHV Connectors
Date Completed:	5/24/96
Base Pressure:	1.57E-6 torr
End Clock Reading:	337.1 hrs
Total Bakeout Time:	81.0 hrs
Notes:	everything worked nicely

Table 8. 4x10 Test Chamber Pre-bake #5

Pre-Bake Number:	5
Start Date:	5/24/96
Chamber Closeout Date:	5/24/96
Data File:	AXAF5.prn
Start Clock Reading:	337.1 hrs
Bake-out Temperature:	200 degrees F
Cable ID Numbers:	WCV 162, WCV 152, WCV144, WCV 158, WCV 149, WCV 150, WCV 160, WCV 151, WCV 161, WCV 139, WCV 157, WCV 272, WCV 273, WCV274, WCV 276, WCV 277, WCV 278, WCV281, WCV 282, WCV 283, WCV 285, WCV 286, WCV 287 HXDS 5319, WMV 259, WMV 258 WCV 264, WCV 265, WCV266, WCV 267 WCV 284, WCV 280, WCV 275, WCV271 4 LED/Transmitters with 4 T/Cs .(BND-H)
Date Completed:	5/28/96
Base Pressure:	1.38E-6 torr
End Clock Reading:	426.1 hrs
Total Bakeout Time:	89 hrs
Notes:	everything worked nicely

Table 9. 7V Antechamber 1238 Cable Certification #1

Test Run Number:	1
Start Date:	5/30/96
Data File:	Cert1.prn
OWS ID number:	89-96
TQCM Line of Sight:	SAO cables
TQCM Temperature:	10 degrees C
Certification Temperature:	160 degrees F
TQCM Dep. Rate at OWS Exposure:	0.58 - 0.73
Time to Reach Deposition Rate:	4 days
OWS Temperature:	10 degrees C
OWS Exposure Time:	24 hrs and 30 minutes
Date Completed:	6/5/96
Base Pressure:	2.74E-7 torr
Cable ID Numbers:	HXDA WMV 320 HXDA WMV 315 HXDA WMV 316 HXDA WMV 314

	HXDA WMV 319 HXDA WMV 311

Table 10. 7V Antechamber 1238 Cable Certification #2

Test Run Number:	2
Start Date:	6/6/96
Data File:	Cert2.prn
OWS ID number:	68-96
TQCM Line of Sight:	SAO cables
TQCM Temperature:	10 degrees C
Certification Temperature:	160 degrees F
TQCM Dep. Rate at OWS Exposure:	0.6
Time to Reach Deposition Rate:	12 days
OWS Temperature:	10 degrees C
OWS Exposure Time:	24 hrs and 7 minutes
Date Completed:	6/18/96
Base Pressure:	2.2E-7 torr
Cable ID Numbers:	HXDA WMV 290 HXDA WMV 288 HXDA WMV 289 HXDA WMV 313 HXDA WMV 312 HXDA WMV 318 HXDA WMV 159